EIC NC structure functions study

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Work together with Krishna Kumar, Abhay, Seamus, Jin, Nils

Introduction

- What we want to do:
  - Parity violating asymmetry (gamma-z mixing) of inclusive electrons
    - Polarized electron and unpolarized nucleon: F1GZ, F3GZ
    - Unpolarized electron and polarized nucleon: G1GZ, G5GZ
- DJANGOH generator:
  - Simulates DIS lepton-proton (nuclei) scattering with QED and QCD radiative effects to NLO

Electron beam asymmetry (F1GZ, F3GZ)

$$A_{beam} = \frac{G_F Q^2}{2\sqrt{2}\pi\alpha}\left[g_A^e \frac{F_1^{\gamma Z}}{F_1^{\gamma}} + g_V^e \frac{Y_-}{2Y_+}\frac{F_3^{\gamma Z}}{F_1^{\gamma}}\right]$$

$$g_A^e = -0.5, \qquad g_V^e = -0.5 + 2sin^2(\theta_W)$$

$$Y_- = 2y - y^2, \qquad Y_+ = y^2 - 2y + 2.$$

$$F_1^{\gamma Z} = \sum_q e_q (g_V)_q (q + \bar{q}),$$

$$F_3^{\gamma Z} = 2\sum e_q (g_A)_q (q - \bar{q}),$$

Nucleon target asymmetry (G1GZ, G5GZ)

$$A_L = \frac{G_F Q^2}{2\sqrt{2}\pi\alpha}\left[g_V^e \frac{g_5^{\gamma Z}}{F_1^{\gamma}} + g_A^e \frac{Y_-}{Y_+}\frac{g_1^{\gamma Z}}{F_1^{\gamma}}\right]$$

$$g_1^{\gamma Z} = \sum_q e_q (g_V)_q (\Delta q + \Delta\bar{q}),$$

$$g_5^{\gamma Z} = \sum_q e_q (g_A)_q (\Delta q - \Delta\bar{q}),$$

For each (Q2,x) bin, the asymmetry is fitted in Y dimension to extract structure functions

Bin migrations

- For the measured i^{th} (Q^2, x, y) bin
  - $\nu_i = \sum_j R_{ij}\mu_j$, ν *is the measured yield*, μ *is the truth yield*
  - R_{ij} *presents the ratio of events migrated into the* i_{th} *bin with truth kinematics in the* j_{th} *bin*
  - R^{-1} reconstructs the "truth" yield

- Migration source:
  - Radiation (what we have got in the summer of 2015, see the talk by Krishna Kumar at POETIC 2015)
  - Detection resolution (to be updated in this talk)

Parametrized detection resolution of inclusive electrons

------Barrel: -1.1<eta<+1.1

Tracking:

dpT/pT = 0.65% (+) 0.09%*pT, [2] Fig 4.32

dTheta ~ 10 mrad

dPhi ~ 0.3mrad

EMCal:

dE/E = 3.0% (+) 11.7%/Sqrt(E). [2] Fig 5.23

------Forward: eta > 1.1 (in my simulation using DJANGOH, electron going direction is the positive direction)

Tracking:

dpT/pT ~ 0.65% (+) 1%*pT, [1] Fig 3.4

dTheta ~ 1 mrad

dPhi ~ 0.3mrad

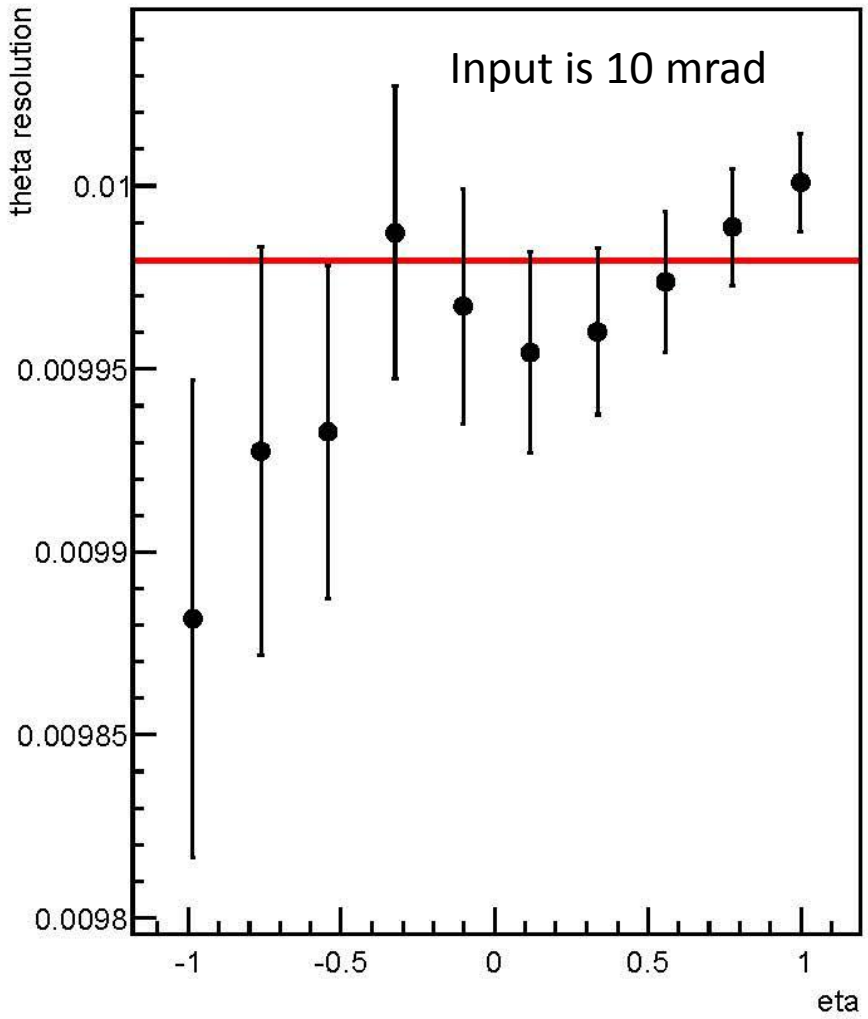
EMCal:

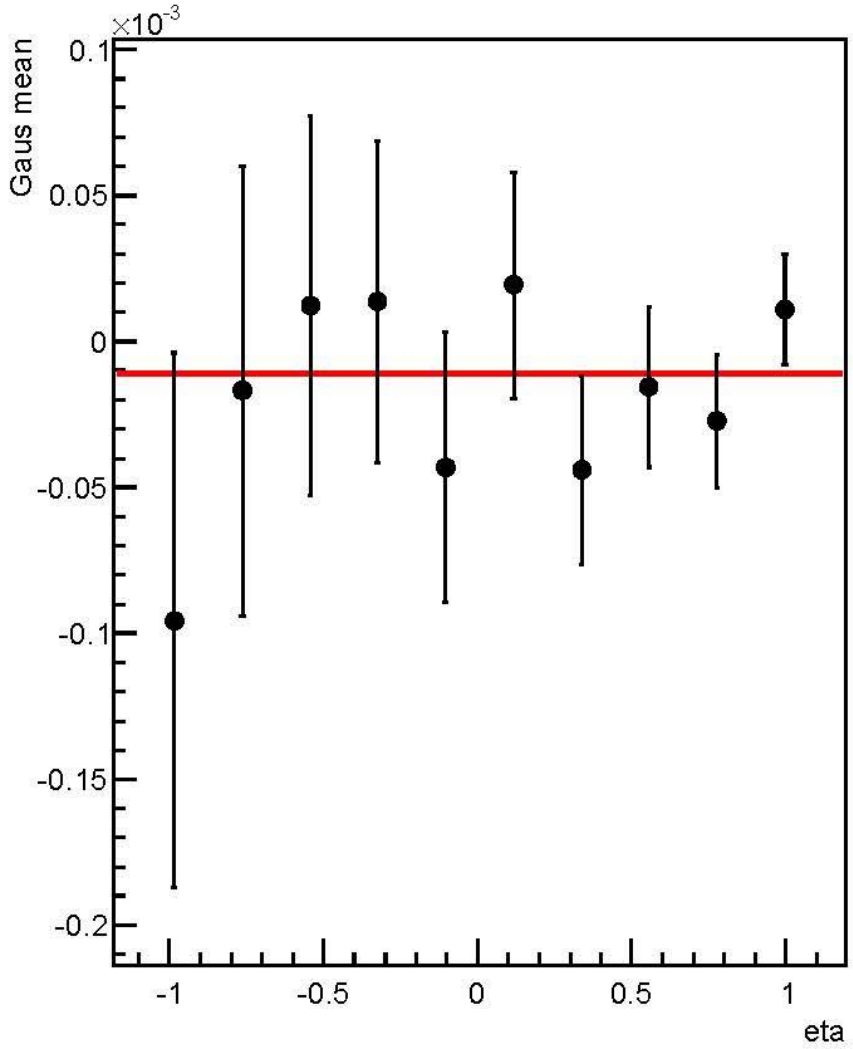
dE/E = 1.0% (+) 2.5%/Sqrt(E). [1] Sec 3.3.1

Reference [1] ePHENIX letter of intent: http://arxiv.org/abs/1402.1209

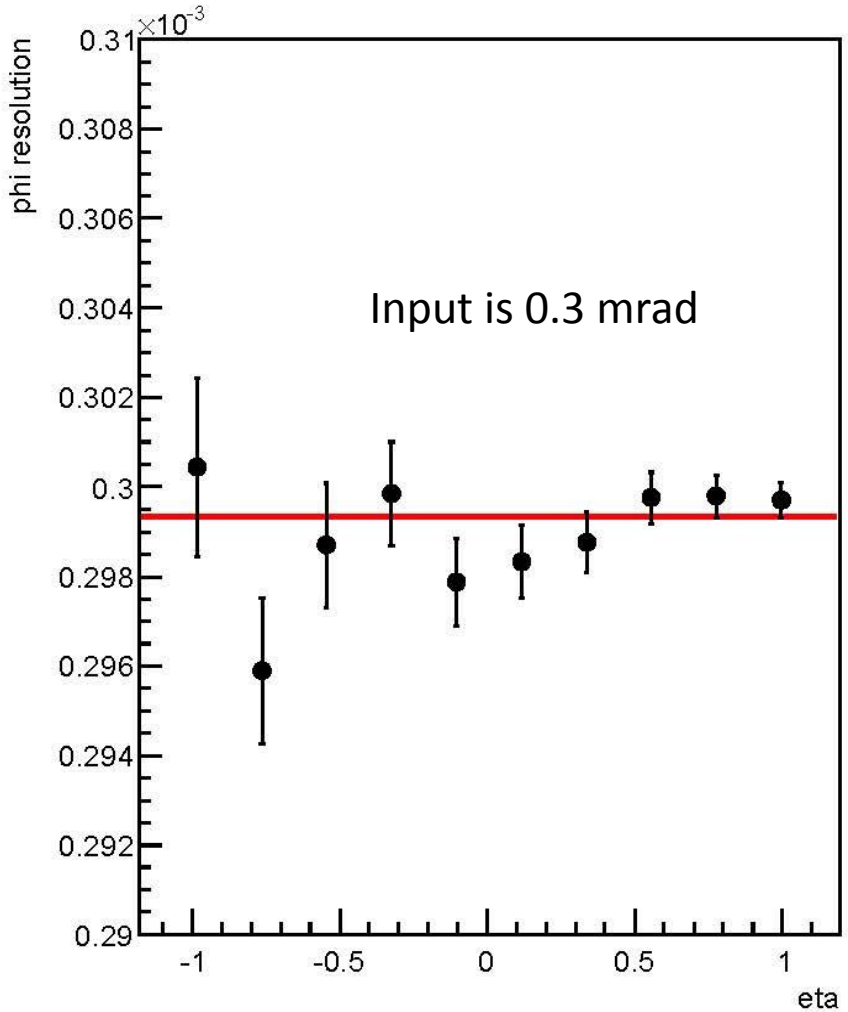
Reference [2] sPHENIX pre-CDR design report: https://indico.bnl.gov/conferenceDisplay.py?confId=1483

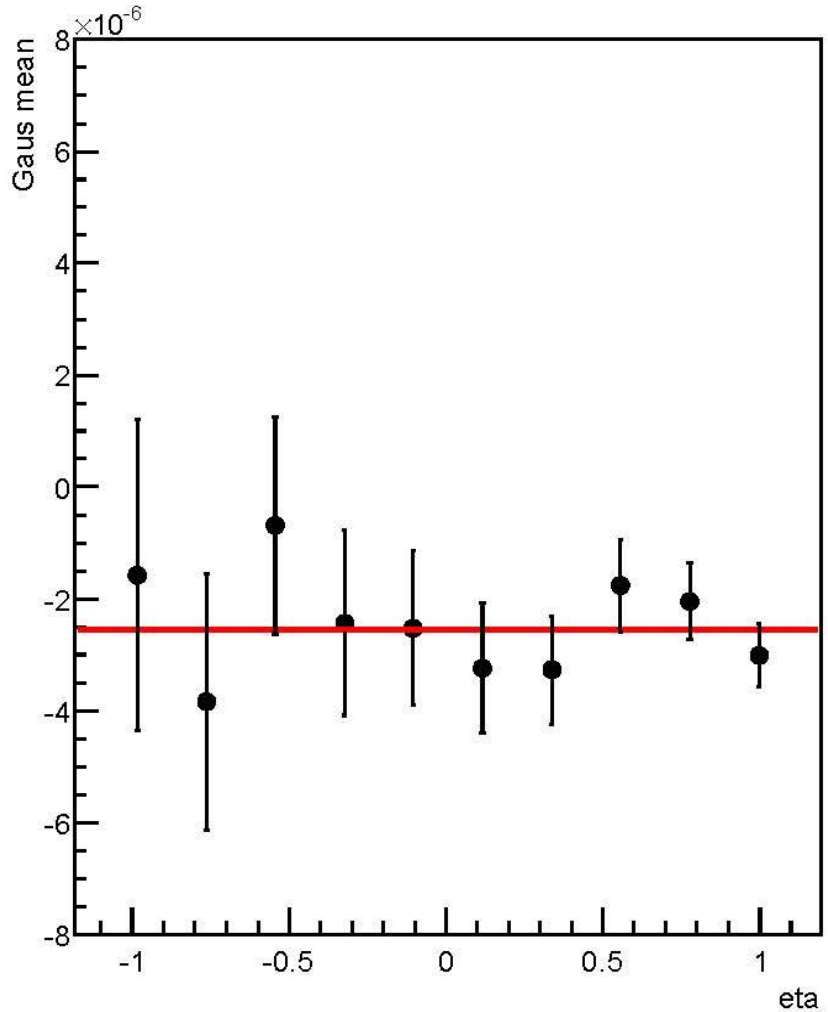
Cross check of the imbedded detector smearing ---theta





Cross check of the imbedded detector smearing ---phi

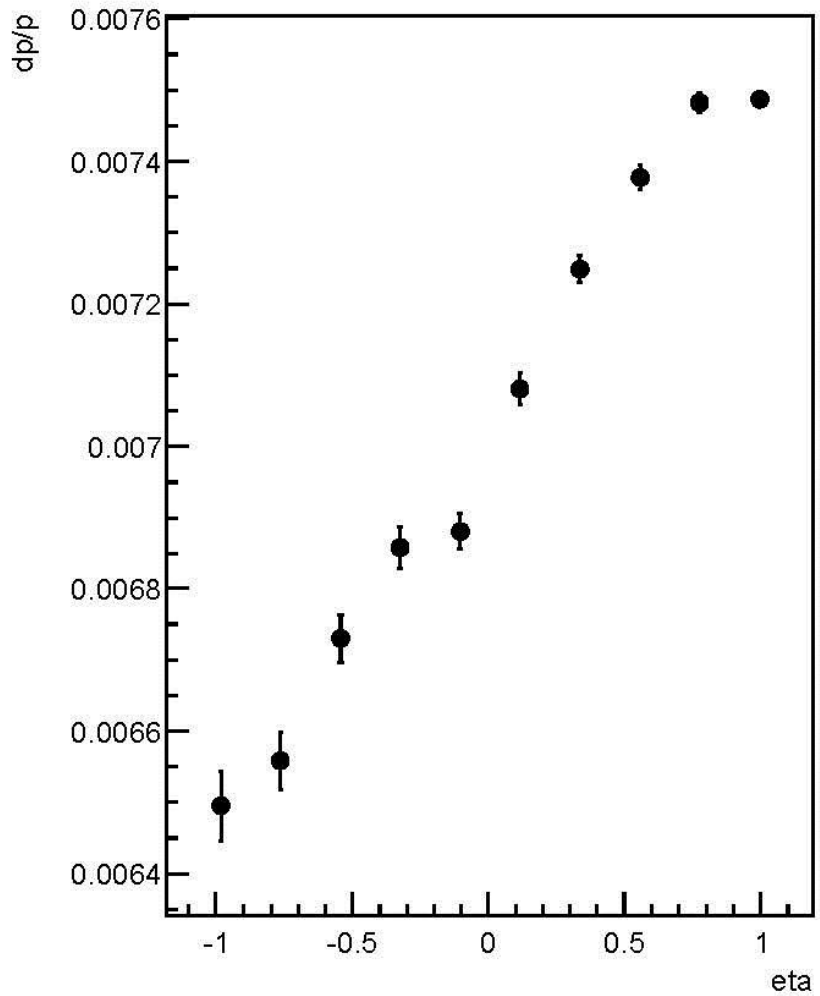


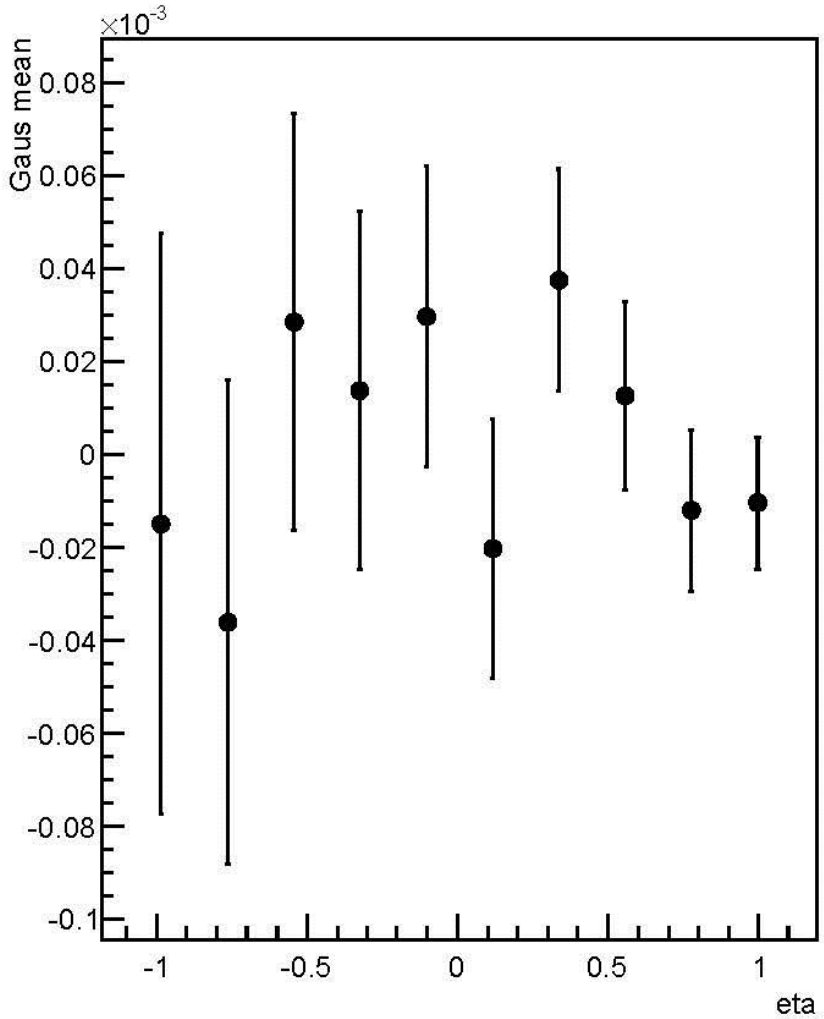


Cross check of the imbedded detector smearing

---p

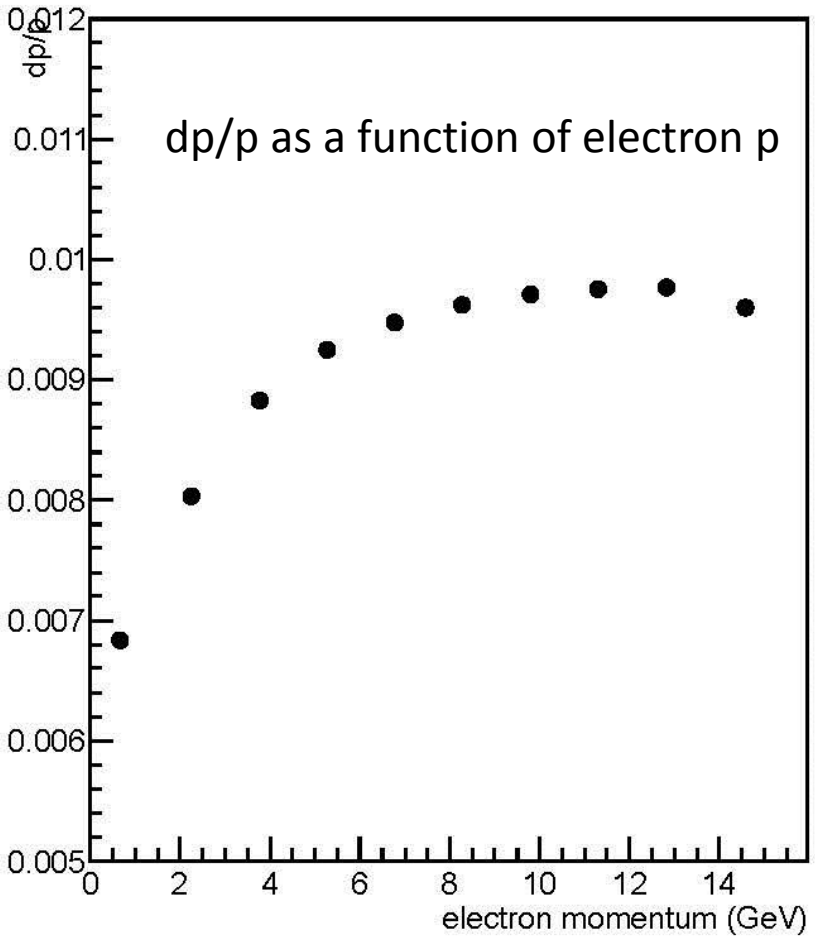
dp/p as a function of eta (-1.1, 1.1)



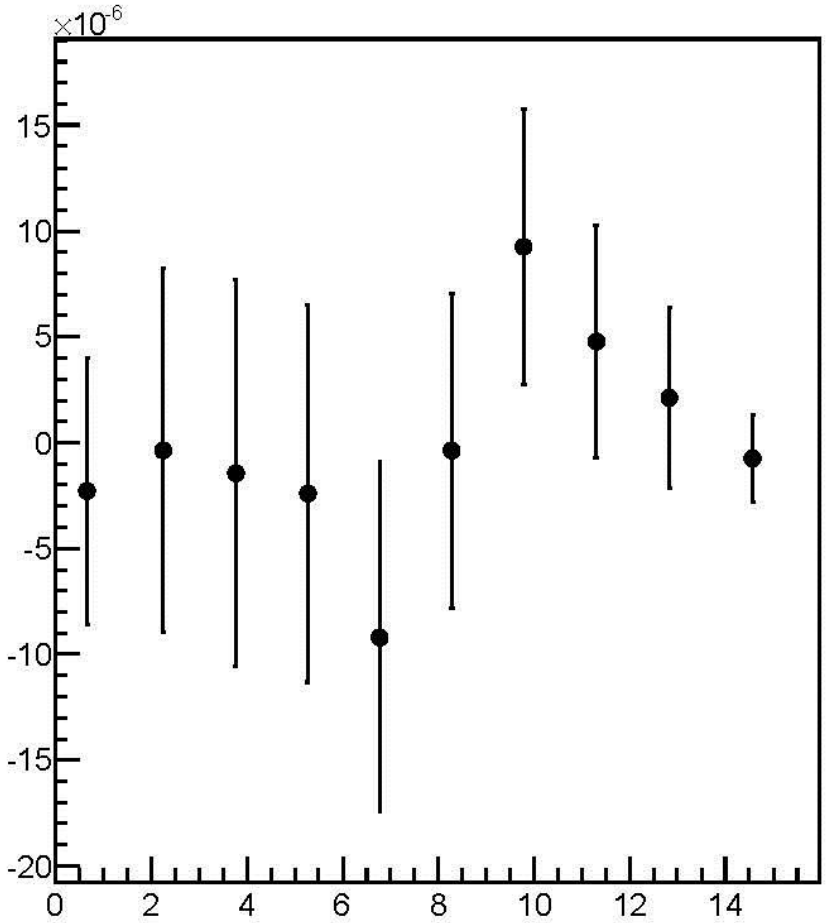


Cross check of the imbedded detector smearing

---p



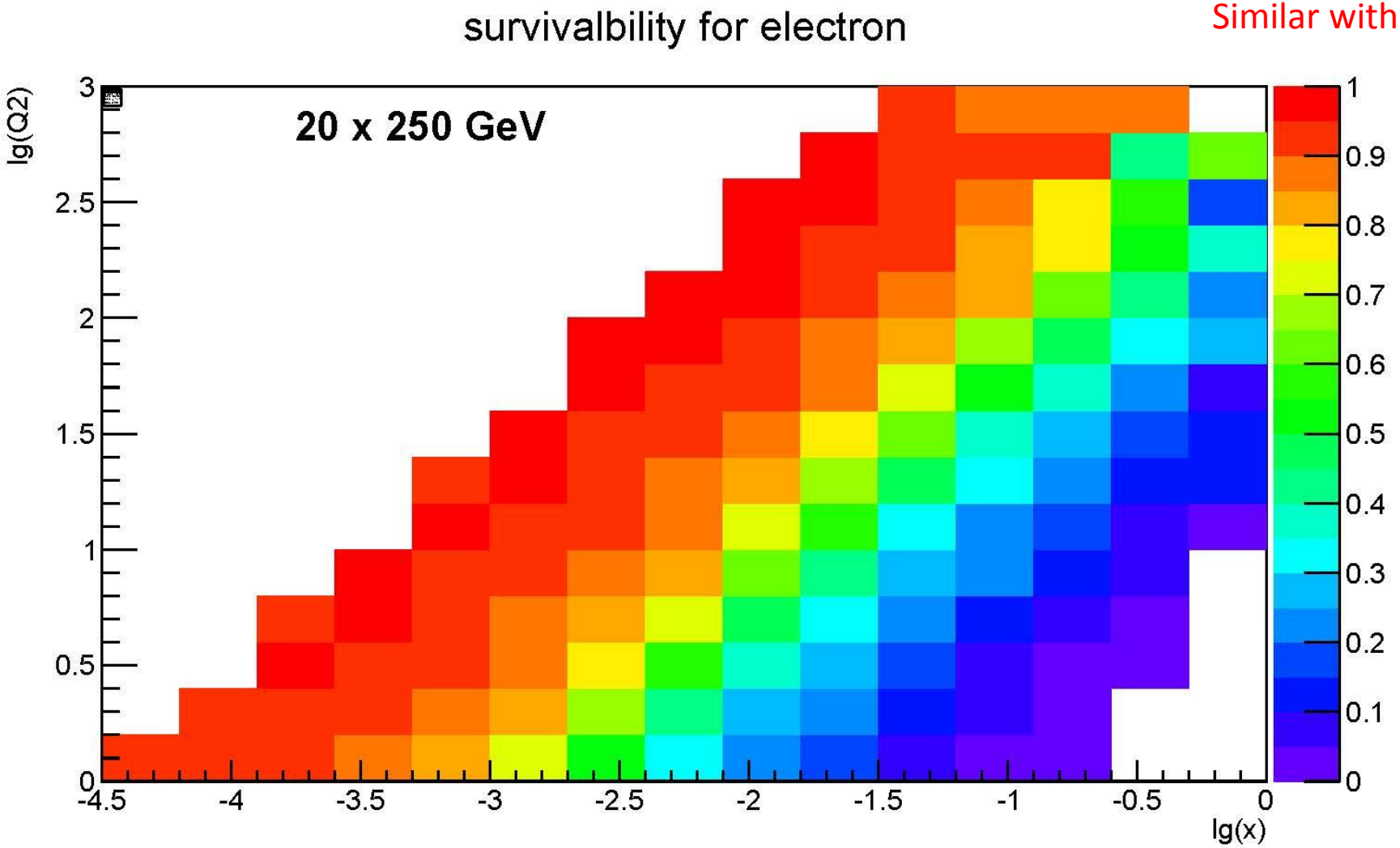
Gaus mean



Electron momentum (GeV)

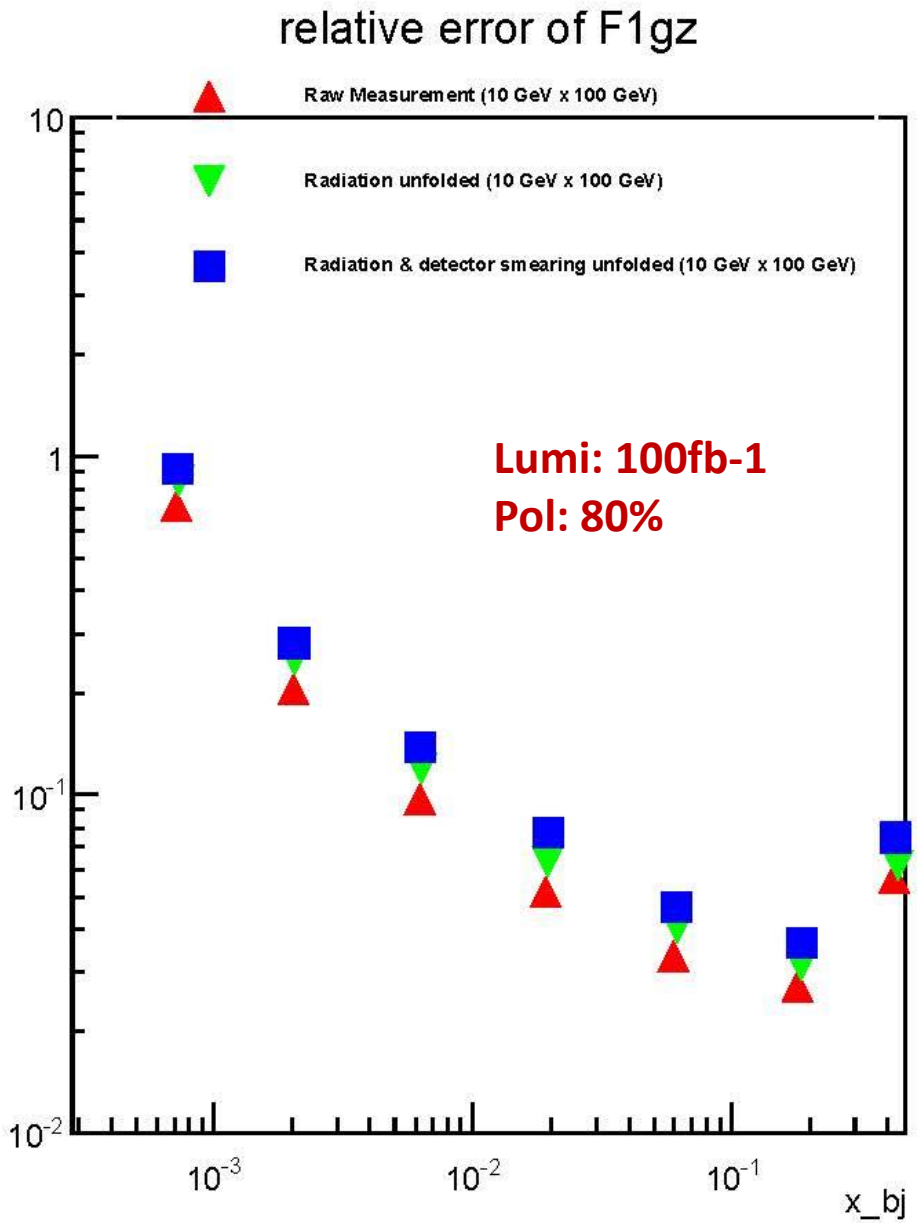
Cross check of the imbedded detector smearing

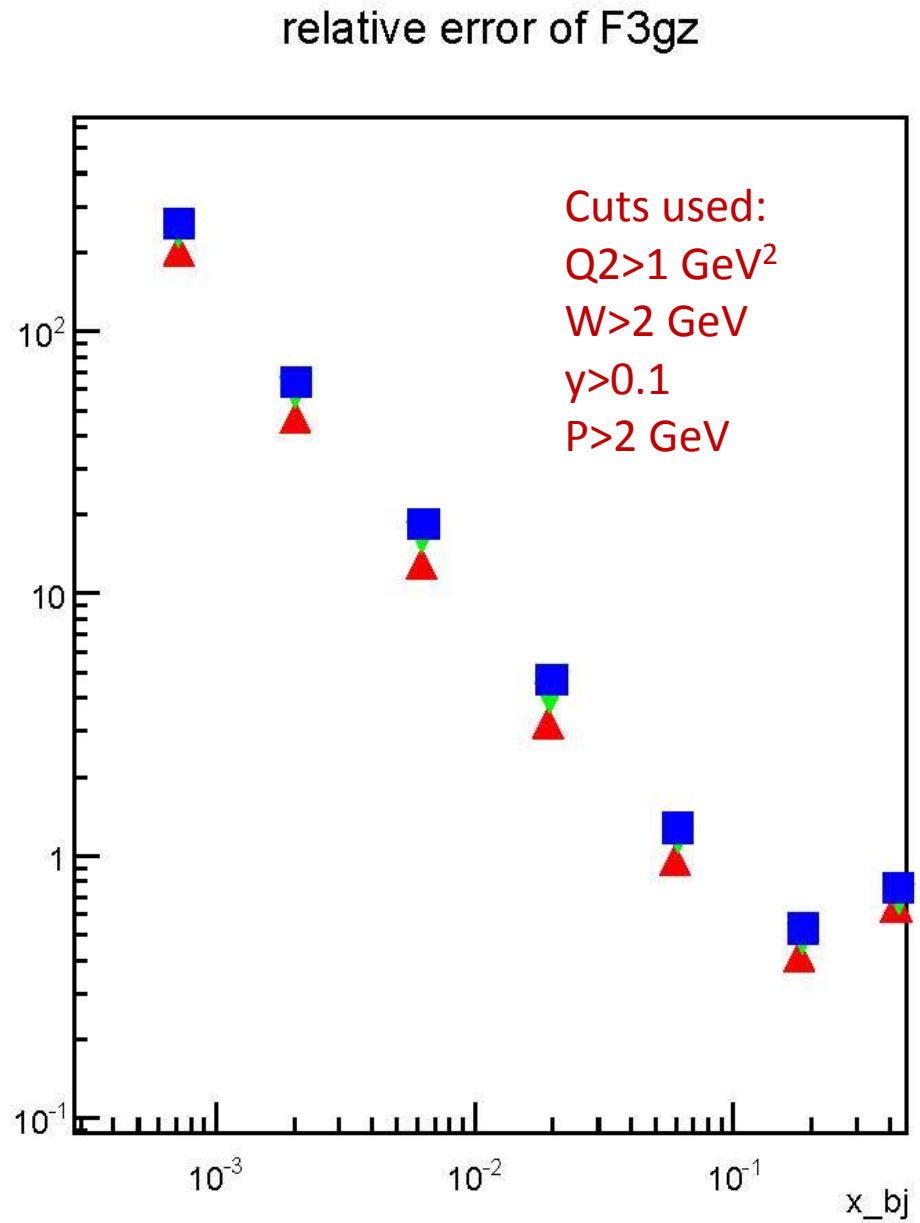
---Bin survivability



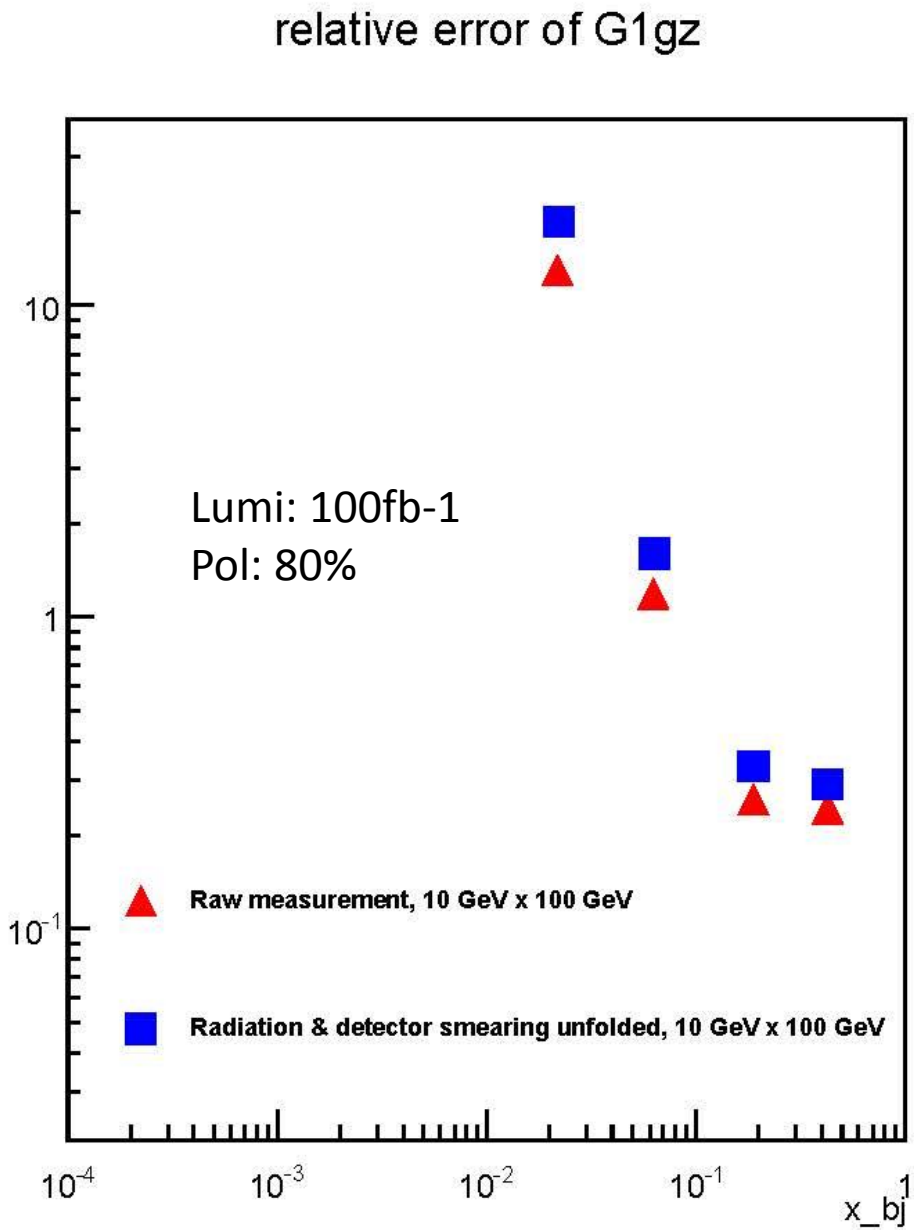
Similar with Sasha's plot

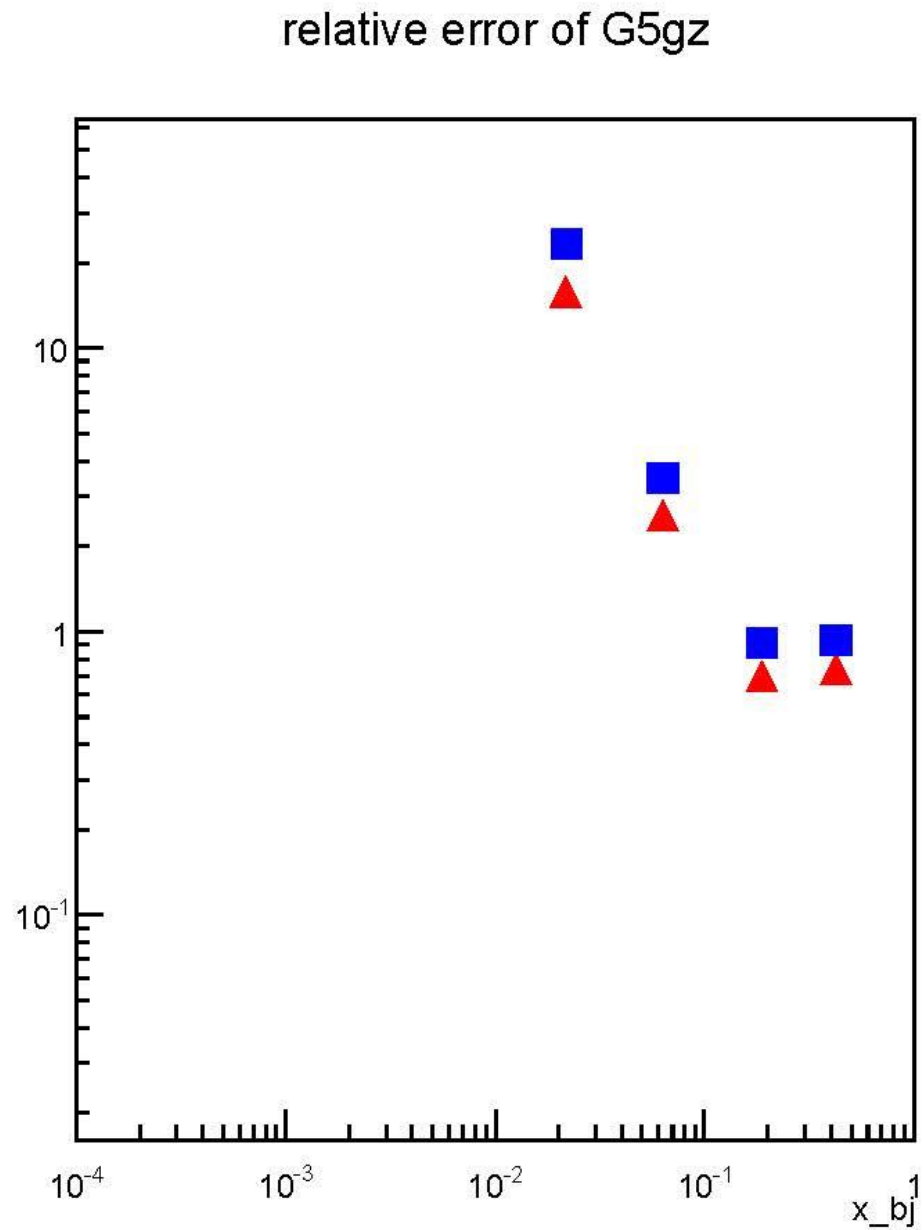
F1GZ, F3GZ projections





G1GZ, G5GZ projections



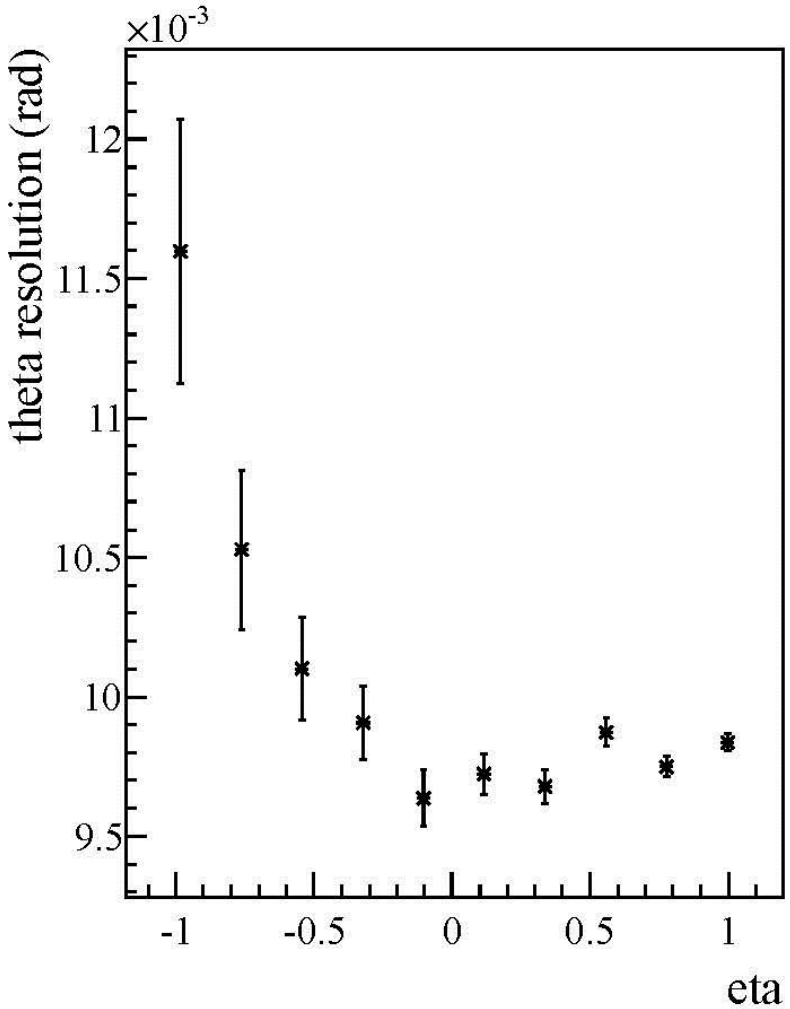


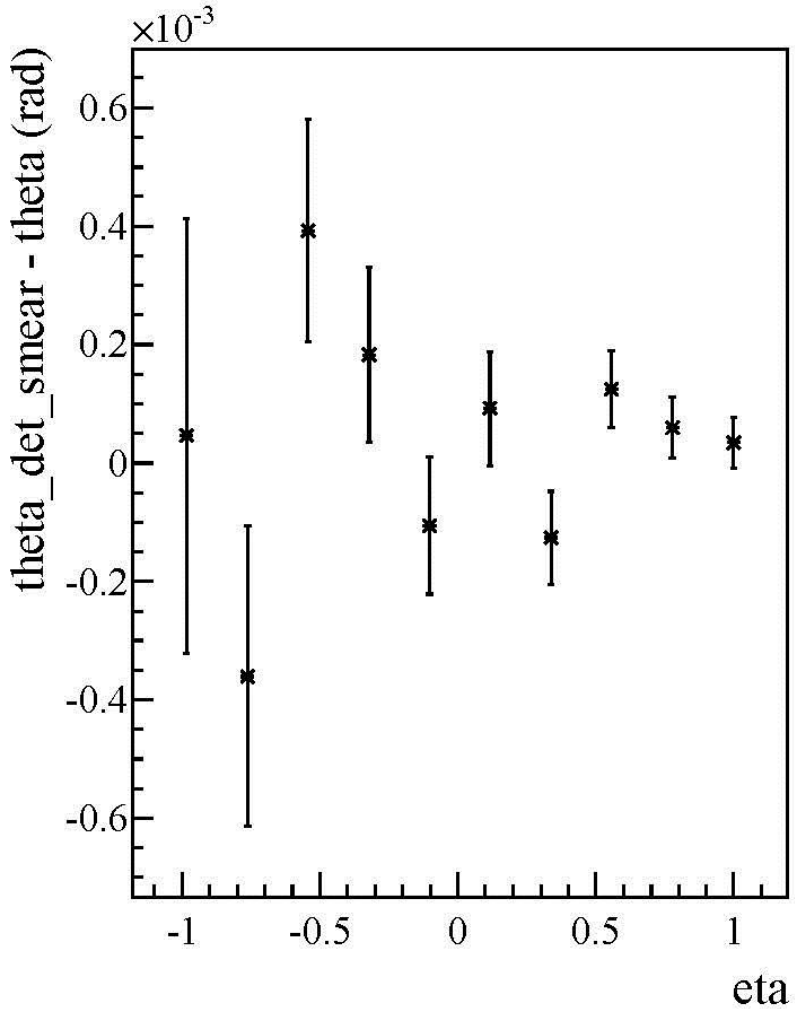
Summary

- Projections of structure functions for 10 GeV x 100 GeV are shown
- Running other 4 settings:
  - 10 x 250
  - 20 x 250
  - 15 x 100
  - 15 x 250
- Detector smearing study requires huge amount of statistics, each setting costs about one week

Issue with low statistics

---only 20 million events to extract unfolding matrix





Issue with low statistics

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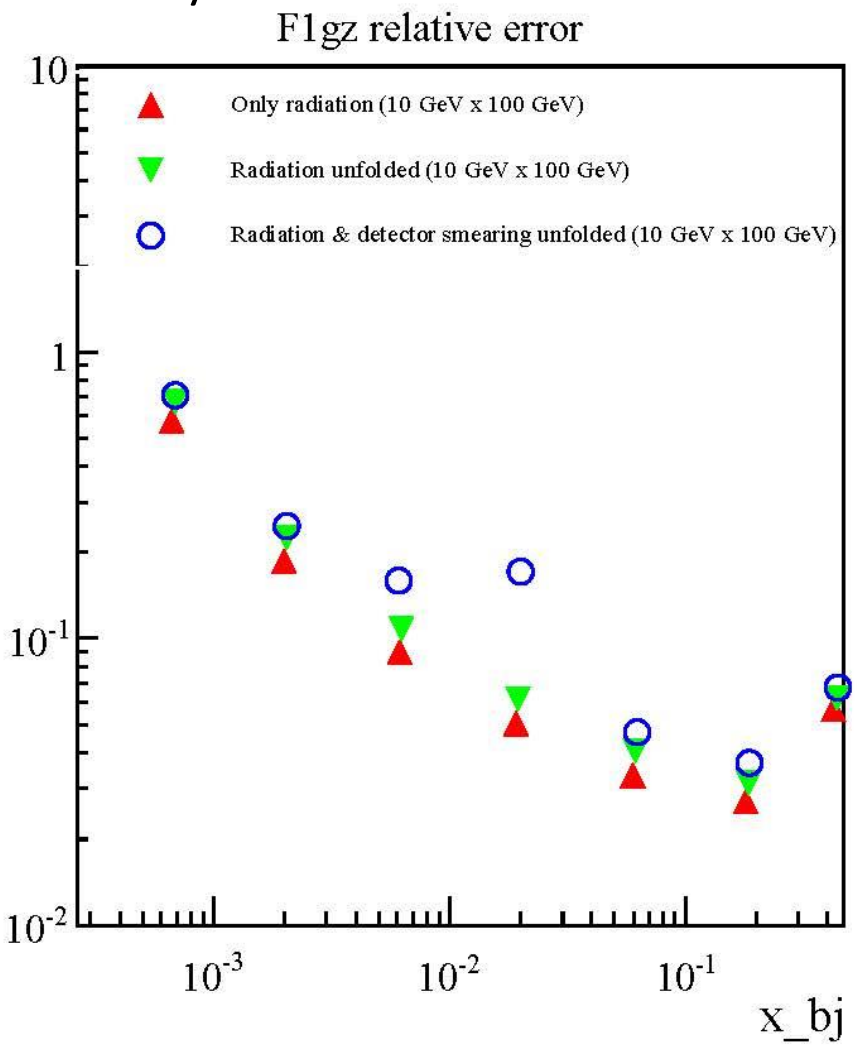

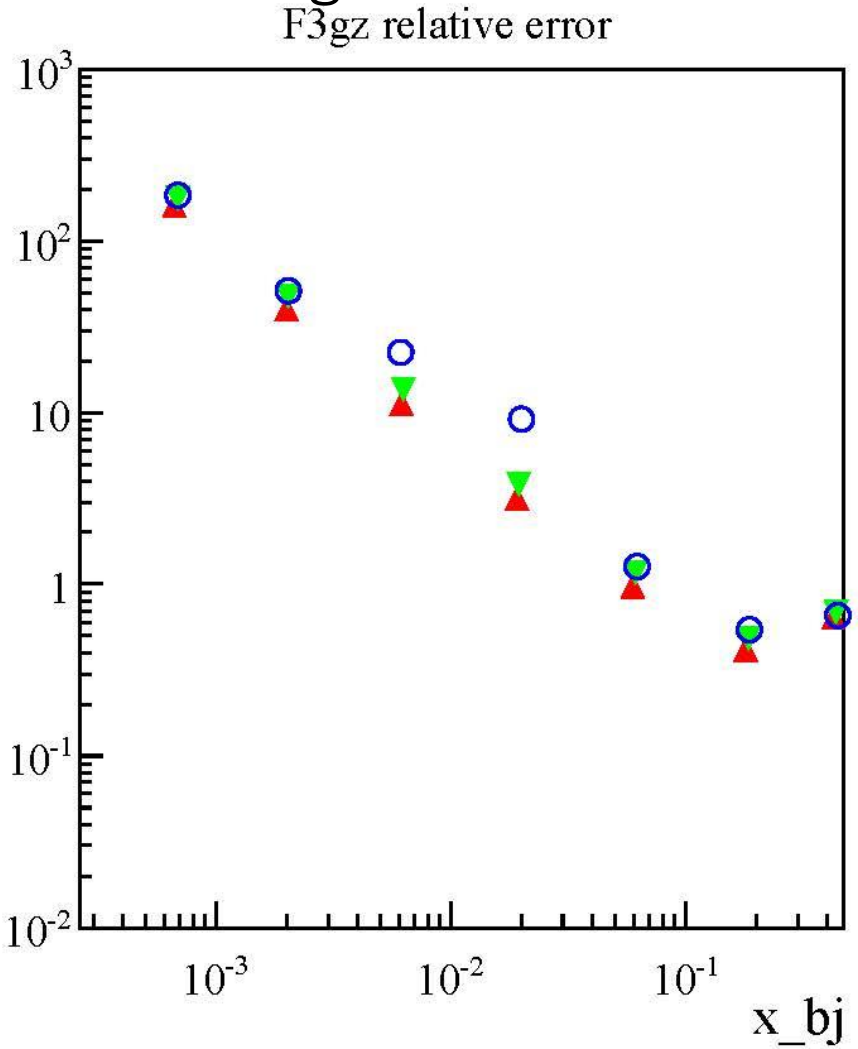

The only difference between page 11 and this page is statistics (100 million VS 20 million)